Fluid-Structure Interaction Through the Use of PFEM

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1)

Work Done

- ✓ Python interface for PFEM3D using Swig.
- ✓ Coupling PFEM3D with CUPyDO for FS interactions.

2)

Current Work

- Finalizing adaptive time step and intermediate remeshing in CUPyDO.
- Allows multiple FS interface in CUPyDO.

3)

Next Work

- ✗ Detection of fluid nodes/elements into the solid.
- ✗ Test-case of flow-driven elastic structure in 2D (see next slides).
- ✗ UCLouvain contribution to the remeshing algorithm.

CUPyDO FSI coupling
- Block Gauss Seidel Coupling Method.
- Incompressible fluid : $\rho = 10^3$ kg/m^3, $\mu = 10^{-3}$ Pa $\cdot$ s
- Hypoelastic solid : $\rho = 2500$ kg/m^3, $E = 10^6$ Pa, $\nu = 0$

- Computation time = **1141** sec

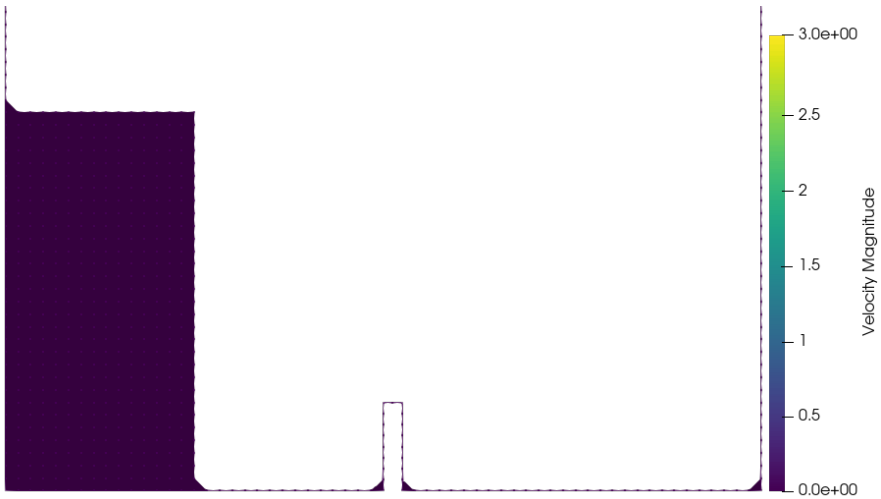


Figure: Plot of $|\mathbf{v}(\mathbf{x}, t)|$ in m/s **(PFEM)**.

- Computation time = **398** sec

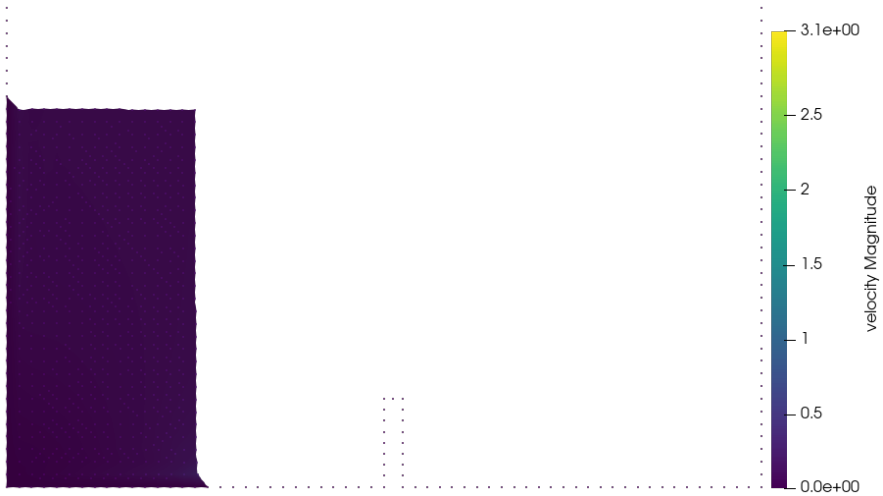
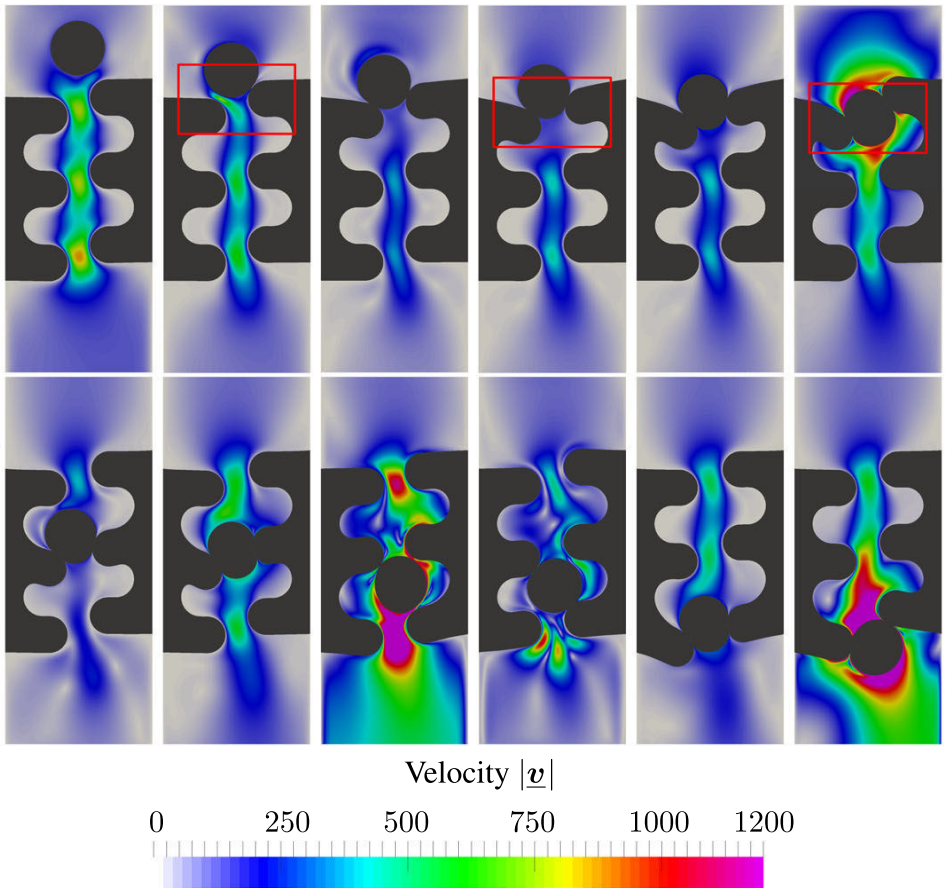


Figure: Plot of $|\mathbf{v}(\mathbf{x}, t)|$ in m/s **(PFEM3D)**.

Christoph Ager et al. (2019): 10.1002/nme.6556.



- **Input Flow**

$$\begin{cases} v_x = 4 \times 10^5 (x^2 - 1) \\ t < 2.5 \times 10^{-4} \end{cases}$$

$$\begin{cases} v_x = 100 (x^2 - 1) \\ t \geq 2.5 \times 10^{-4} \end{cases}$$

- **Neo-Hookean Solid**

$E_b = 100, E_s = 200$

$\nu_b = \nu_s = 0.3$

- **Incompressible Fluid**

$\rho_f = \rho_0 = 10^{-6}$

$\mu_f = 10^{-5}$

Flow-driven elastic structure : Metafor and PFEM3D codes independently.

Imposed displacement (x, y).

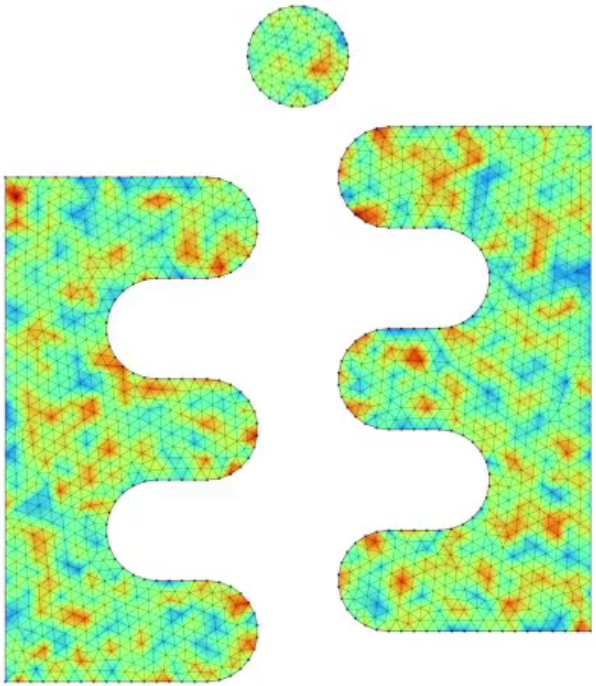


Figure: Plot of $\sigma_{VM}(\mathbf{x}, t)$.

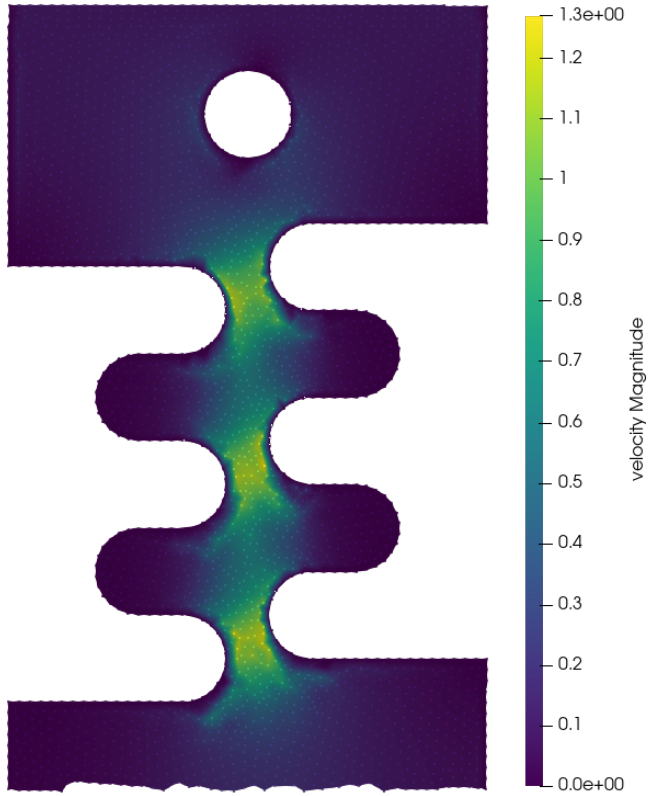


Figure: Plot of $|\mathbf{v}(\mathbf{x}, t)|$ in m/s.

- Adaptive CUPyDO time step for FS interface position computation.
- Intermediate time steps and remeshing for the fluid solver.

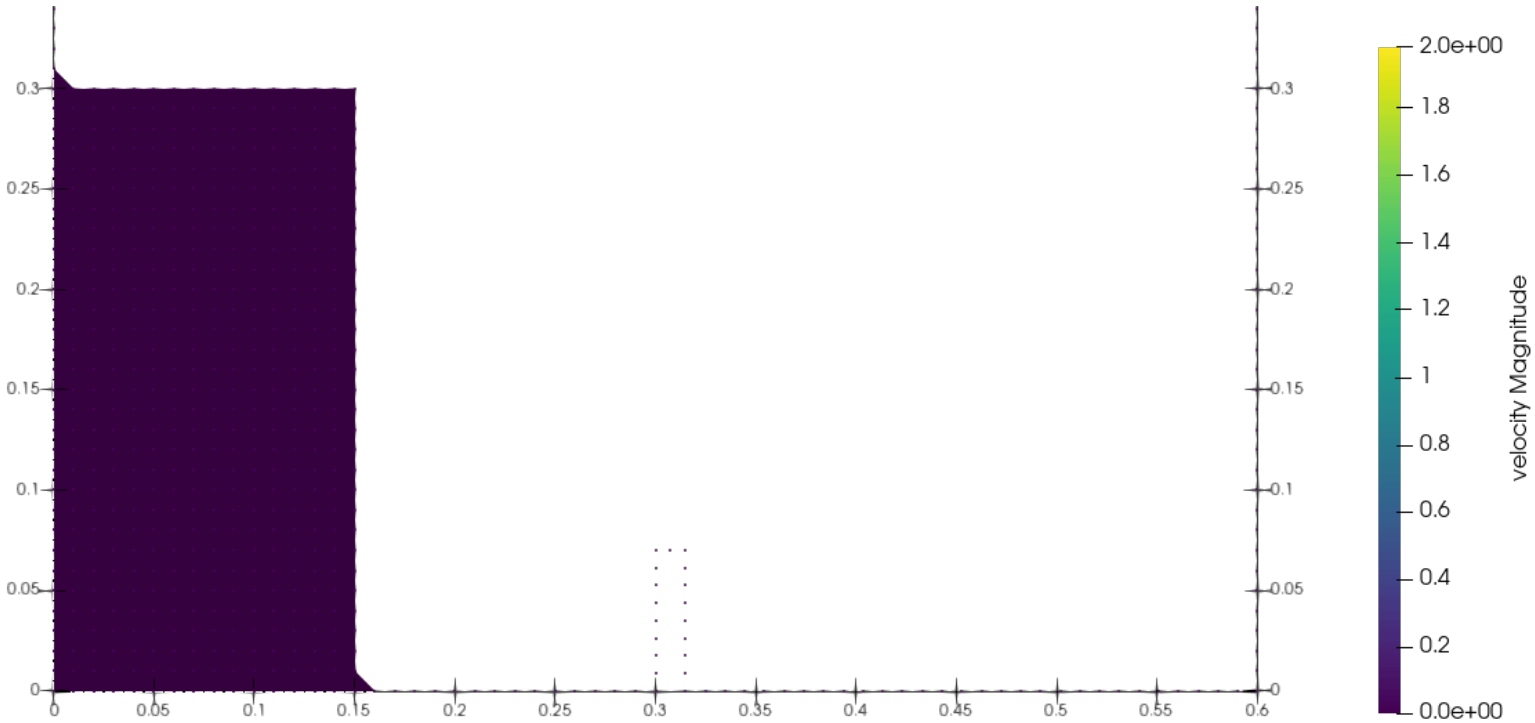


Figure: Plot of $|\mathbf{v}(\mathbf{x}, t)|$ in m/s.